PHYSIOLOGICAL QUALITY OF OSMOPRIMED EGGPLANT SEEDS

Qualidade fisiológica de sementes de berinjela osmocondicionadas

Rodrigo de Góes Esperon Reis[1], Renato Mendes Guimarães[2], Antônio Rodrigues Vieira[2], Nayara Roberto Gonçalves[3], Valéria Hanny Costa[2]

ABSTRACT

Eggplant seeds germination can be slow and uneven, justifying the use of pre-germinative treatments to improve the performance of seed lots. One option of treatment is the controlled hydration of seeds by priming. In this way, this study aimed to evaluate the performance of eggplant seeds cv. Embu submitted to different methodologies of priming. The seeds used in the experiment were stored in cold chamber (15º C and 55% RH) in paper bags. The research was carried out at Central Laboratory of Seeds/UFLA. The seeds were submitted to the priming in aerated solutions varying the following factors: temperature (15° C and 25º C), time (24, 48 and 72 hours) and solution (water, PEG, KNO_3 and PEG+KNO_3). Seeds were washed in running water and dried at 30º C, until the return to the initial moisture content, around 10%. The variables analyzed were percentage of germination, percentage of emergence, speed index of emergence and electrical conductivity. The treatments were arranged in a completely randomized design, according to a factorial arrangement 2x3x4+1 (control – seeds without priming). The results showed that priming improves the vigour of eggplant seeds with no effect on viability; the priming in water or KNO_3 is efficient to improve the seed vigour and priming in water or KNO_3 may use temperature of 15° C or 25° C for 24, 48 or 72 hours.

Index terms: *Solanum melongena*, priming, germination, vigour.

RESUMO

A germinação de sementes de berinjela pode ser lenta e desuniforme, justificando a utilização de tratamentos pré-germinativos para melhorar o desempenho de lotes de sementes dessa espécie. Uma das opções de tratamento é a hidratação controlada das sementes por meio do condicionamento fisiológico. Desse modo, objetivou-se avaliar o desempenho de sementes de berinjela submetidas a diferentes metodologias de condicionamento fisiológico. As sementes utilizadas foram armazenadas em câmara fria (15º C e 55% UR) em embalagens de papel. O trabalho foi desenvolvido no Laboratório Central de Sementes/UFLA. As sementes foram submetidas ao condicionamento fisiológico em solução aerada variando-se os seguintes fatores: temperatura (15° C e 25º C), tempo (24, 48, 72 horas) e solução de condicionamento (água, PEG, KNO_3 e PEG+KNO_3). Em seguida, as sementes foram lavadas em água corrente e secadas a 30º C até retornarem à umidade inicial, aproximadamente 10%. As variáveis respostas foram: porcentagem de germinação, porcentagem e índice de velocidade de emergência e condutividade elétrica. Os tratamentos foram dispostos em delineamento inteiramente casualizado com quatro repetições, de acordo com um esquema fatorial 2x3x4+1 (testemunha - sementes sem condicionamento). Concluiu-se que o condicionamento fisiológico melhora o vigor de sementes de berinjela sem afetar a viabilidade; o condicionamento em água ou KNO_3 é eficiente no envigoramento das sementes de berinjela; para o condicionamento em água ou KNO_3, pode-se utilizar as temperaturas de 15° C ou 25° C e os tempos de 24, 48 ou 72 horas.

Termos para indexação: *Solanum melongena*, condicionamento fisiológico, germinação, vigor.

(Received in march 22, 2012 and approved in august 17, 2012)

INTRODUCTION

The physiological quality of eggplant seeds varies both with the harvest time as with the position of the fruit on the plant (MIRANDA et al., 1992). Many stages of maturation can be observed in an eggplant seed lot, providing a slow and uneven germination, which is undesirable for the seed producers and farmers.

The seed priming can contribute to equal and accelerate seed germination and seedling emergence (BITTENCOURT et al., 2004; KAYA et al., 2006; NASCIMENTO; LIMA, 2008; SANTOS et al., 2008). This treatment consists on the controlled hydration of the seeds, initiating the preparatory processes for germination, but avoiding the radicle protrusion (ASHRAF; FOOLAD, 2005; PANDITA; ANAND; NAGARAJAN, 2007; SANTOS et al., 2008). Beneficial effects of the priming have been observed in many vegetable species, like in lettuce (FESSEL et al., 2002), sugarbeet (COSTA; VILLELA, 2006), onion (CASEIRO;

[1]Universidade Federal de Lavras/UFLA – Departamento de Agricultura/DAG – Cx. P. 3037 – 37200-000 – Lavras – MG – Brasil – guidegoes@gmail.com
[2]Universidade Federal de Lavras/UFLA – Departamento de Agricultura/DAG – Lavras – MG – Brasil
[3]Universidade de São Paulo/USP – Escola Superior de Agricultura "Luiz de Queiroz"/ESALQ – Piracicaba – SP – Brasil

BENNETT; MARCOS FILHO, 2004), carrot (PEREIRA et al., 2008), cauliflower (KIKUTI; MARCOS FILHO, 2009), cucumber (LIMA; MARCOS FILHO, 2010), chili (FIALHO et al., 2010), pepper (KIKUTI; KIKUTI; MINAMI, 2005; ALBUQUERQUE et al., 2009), tomato (VENKATASUBRAMANIAN; UMARANI, 2007) and eggplant (FANNA; NOVEMBRE, 2007; NASCIMENTO; LIMA, 2008). However, even though many studies have shown the efficiency of seed priming in some species, it is important to determine which methodology is more efficient to be used, since many factors are involved.

The hydration of the seeds is controlled by active osmotic solutions that influence the priming effects. Depending on the substance used, problems like the reduction of the oxygen solubility in the solution, toxicity when entering the membrane system of some species, as well as microbial metabolization or degradation (SANTOS et al., 2008) may be observed.

Generally, the temperature used in the seed priming is that recommended for germination, between 15° C and 25° C (MARCOS FILHO, 2005; NASCIMENTO; COSTA, 2009). However, many disagreements can be observed regarding the benefits or damages of the use of low or high temperature. Nascimento and Costa (2009) comment that the metabolism is reduced when the priming occurs under low temperatures, and that the germination and the development of microorganisms are inhibited. However, Marcos Filho (2005) relates that in these conditions, some delays or failures can occur in the membrane reorganization, causing damages during the imbibition. On the other hand, high temperatures allow a faster hydration of the seeds, reducing the time of priming (NASCIMENTO; COSTA, 2009).

Many factors can affect the time of priming. Short times may not provide effective success to the treatment. On the other side, extended times may allow seed germination during the treatment or harm the seed vigour (NASCIMENTO; COSTA, 2009).

For eggplant seeds, various priming methodologies have been tested using pure water, PEG and KNO_3, from 0 to 1.6 MPa, at 15° C and 20° C for until 96 hours (FANAN; NOVEMBRE, 2007; NASCIMENTO, 2005; NASCIMENTO; LIMA, 2008; TRIGO; TRIGO, 1999).

In this context, it was aimed to evaluate the performance of eggplant seeds submitted to different methodologies of priming.

MATERIAL AND METHODS

The experiment was performed at the Central Laboratory of Seed Analisys in the Universidade Federal de Lavras (UFLA). The seeds used in this experiment were produced in 2007 and stored in cold chamber (15° C and 55% RH) in paper bags until march of 2010. Eggplant seeds cv. Embu, with moisture content around 10% and percentage of germination around 80%, but with low level of vigour were used.

The seeds were submitted to the priming in aerated solution, in the following conditions: temperature (15° C and 25° C), time (24, 48 and 72 hours) and priming solution (water, polyethylene glycol 6000 – PEG, potassium nitrate – KNO_3 and PEG+KNO_3). The water potential of the solutions was equal to -0.8 MPa, (FANAN; NOVEMBRE, 2007; NASCIMENTO, 2005; NASCIMENTO; LIMA, 2008; TRIGO; TRIGO, 1999), and the distilled water, zero. After the priming, the seeds were washed in running water and dried at 30 °C up to 10% moisture.

The water potential of the PEG solution was obtained according to the equation proposed by Michel and Kaufmann (1973) and the concentration of the KNO_3 solution was determined according to the Van't Hoff's equation (HILLEL, 1971). The solution of PEG+KNO3 was prepared using the combination of both pure solutions, in the proportion of 1:1 (v/v).

The following determinations were performed: **seed moisture content** – two samples of 100 seeds were used in heater at 105 ± 3° C during 24 hours (BRASIL, 2009); **percentage of germination** – four replicates of 50 seeds of each treatment were sown in gerbox under two layers of blotter-paper wetted with distilled water in a quantity equivalent to 2.5 times the dry weight of the paper. After the sowing, the gearboxes were maintained in BOD chamber with alternated temperature (20-30° C) and a 12 hours photoperiod. The percentage of normal seedling was evaluated at the 14th day after the sown (BRASIL, 2009); **percentages of emergence** – four replicates of 50 seeds of each treatment were sown in plastic trays containing wetted substrate (60% of the water-holding capacity of the substrate) composed of sand and soil (2:1 v/v). After the sowing, the trays were maintained in growth chamber at 25° C until the 14th day after the sowing, when the percentage of normal emerged seedlings was obtained; **speed index of emergence** – daily counts of the emerged seedlings were performed and the speed index of emergence according to Maguire (1962) was calculated; **electric conductivity** – four replicates of 50 seeds of each treatment were weighted and then immersed in 50 mL deionized water at 25° C. After 24 hours, the electric conductivity of the solution was evaluated using a conductivimeter (DIGIMED CD-21) and the results were expressed in $\mu S\ cm^{-1}\ g^{-1}$ seeds.

The experimental design used was completely randomized with four replicates in a factorial scheme 2x3x4 plus a control (seeds without priming). After the analyses of variances, the means were compared by the Tukey test at 5% probability (BANZATTO; KRONKA, 2006). The comparisons between the control and each treatment from the factorial used the Dunnett test at 5% probability (BANZATTO; KRONKA, 2006).

RESULTS AND DISCUSSION

The initial seed moisture content (control) was equal to 10.6% (Table 1). In general, in seeds primed at 15° C higher moisture content and smaller variation among the seeds submitted to the different solutions of priming (from 34.5% until 38.9%) were observed. It may be occurred due to the precipitation of the solute, verified during the priming at this temperature. In this way, there was more water available for imbibition, providing higher moisture content in these seeds. At 25° C, there was higher variation among the solutions and the lowest means were verified on seeds primed in PEG (from 18.8 up to 22%), showing that the imbibition was controlled by the water potential of the solution. The highest moisture contents were observed on seeds immersed only in water (from 31.8% until 35.3%), in which the hydration was not controlled, due to the high water potential (around zero). For seeds primed with KNO_3, intermediate values (from 27.0 up to 32.7%) were observed. Even though there are a control of the imbibition by the water potential of the solution, the potassium nitrate is dissociated in ions, which may be absorbed by seeds (TRIGO; NEDEL; TRIGO, 1999), reducing seed water potential and increasing the water imbibition.

Table 1 – Means of moisture content (%) of eggplant seeds cv. Embu primed at two temperatures, four solutions, three times and the control.

Temperature	Priming solution	Time (hours)		
		24	48	72
15º C	Water	37.5	36.6	37.4
	PEG-6000	35.6	35.0	34.8
	KNO_3	37.3	35.6	38.9
	PEG+KNO_3	34.5	36.2	36.5
25º C	Water	31.8	35.1	35.3
	PEG-6000	22.0	18.8	19.7
	KNO_3	32.7	32.7	30.2
	PEG+KNO_3	27.0	27.0	27.7
Control		10.6		

The highest percentages of germination were obtained from seeds primed in water and in 90% and 89% KNO_3, (Table 2). On the other hand, the seeds primed in PEG presented the lowest values of germination (84%). For seeds primed in PEG+KNO_3 solution, intermediate value was observed (88%), which did not differ significantly from other treatments. Trigo and Trigo (1999) also observed that the priming in water and in KNO_3 is efficient to improve the germination of eggplant seeds. Similar results were verified by Nascimento and Lima (2008), in which the priming of eggplant seeds in PEG decreased germination, while the use of KNO_3 provided the best results.

Table 2 – Means of percentage of germination of eggplant seeds cv. Embu primed in four different solutions.

Priming solution	Germination (%)
Water	90 a[1]
PEG	84 b
KNO_3	89 a
PEG+KNO_3	88 ab

[1]Means followed by the same letter do not differ by the Tukey test at 5% probability.

Although significant differences were observed among the percentages of germination and the different solutions of priming used, when the treatments were compared with the control (82%), no significant difference was observed (Table 3). Nascimento and Lima (2008) comment that the germination test is performed under optimum conditions of temperature and water availability. In this way, seed lots with similar viability and with different vigour levels would not differ using this test.

At 15° C, the highest mean of percentage of emergence occurred in seeds primed in water (84%) and KNO_3 (90%) (Table 4). When PEG+KNO_3 was used, a decrease in the seedling emergence (78%) was observed and it was lower (67%) using only PEG. At 25° C, the highest percentages of emergence were observed using water (89%) and PEG+KNO_3 (85%). The lowest mean was verified in seeds primed in PEG (75%). When only KNO_3 was used, the mean of the percentage of emergence was 84%, and did not differ from the other treatments. Comparing with the control (Table 3), the priming provided an increase in the percentage of emergence, standing out the treatments that used water and KNO_3. Trigo and Trigo (1999) also observed increase in the percentage of emergence, in relation to seeds without priming, when eggplant seeds were primed in water and KNO_3.

For speed index of emergence, priming at 15° C, highest means were observed in seeds primed in water (5.71) and in KNO_3 (6.19), followed by PEG+KNO_3 (4.94) (Table 4). At 25° C, no significant difference was observed when the seeds were primed in water (5.62), KNO_3 (5.42) and in PEG+KNO_3 (5.18). In both temperatures, it was verified that PEG was not so effective to improve seed vigour, presenting the lowest seedling speed index of emergence. Similar results were obtained by Kikuti and Marcos Filho (2009) and Fialho et al. (2010), who also observed increases in the speed index of germination after the priming of cauli-flower and chili, respectively.

The results of emergence presented in table 4, show that priming increased seed vigour, mainly in the treatments with water and KNO_3, while, in relation to the control, no significant effects on the percentage of germination were observed (Table 3). Trigo, Nedel and Trigo (1999) comment that the advantage of priming with KNO_3 may be related to the fact that this may act as an additional source of potassium and nitrogen during seed germination. Other researchers claim that the nitrate combined with some environmental factors, like temperature and light, may stimulate the synthesis of gibberellins and promote germination (SAINI; BASSI; SPENCER, 1985; HILHORST; SMITT; KARSSEN, 1986).

Table 3 – Comparison between the control and each treatment from the factorial to the percentage of germination (PG), percentage of emergence (PE), speed index of emergence (SIE) and electric conductivity (EC – μS cm^{-1} g^{-1}).

Solution of Priming	Time (hours)	PG		PE		SIE		EC	
		Temperature (ºC)							
		15	25	15	25	15	25	15	25
Water	24	91	87	84*	93*	5.65*	5.90*	29.64*	22.21*
	48	89	94	81	90*	5.46*	5.49*	35.88*	26.43*
	72	90	91	87*	85*	6.02*	5.48*	28.04*	21.49*
PEG	24	83	82	67	74	3.84	4.37	39.72*	46.61*
	48	88	89	67	74	4.11	4.17	42.75*	39.05*
	72	80	82	67	79	4.18	4.38	38.81*	35.67*
KNO_3	24	94	89	91*	80	6.10*	4.83	61.32*	62.53*
	48	93	87	87*	82	5.97*	5.37*	71.67*	63.89*
	72	83	87	92*	89*	6.49*	6.06*	64.77*	48.05*
PEG+KNO_3	24	88	83	81	82	5.10	4.92	42.68*	42.75*
	48	84	91	74	90*	4.70	5.44*	50.82*	42.92*
	72	88	94	79	84*	5.02	5.17*	67.04*	43.50*
Control		82		66		3.99		105.08	
LSD[1]		13		17		1.15		20.09	

[1]Least significant difference. Means followed by * do not differ by Dunnett test at 5% probability.

Table 4 – Means of percentage and speed index of emergence (SIE) of seedlings from seeds primed in four solutions and two temperatures.

Solution of Priming	Emergence (%)		SIE	
	15º C	25º C	15º C	25º C
Water	84 abA[1]	89 aA	5.71 aA	5.62 aA
PEG	67 cB	75 bA	4.04 cA	4.31 bA
KNO_3	90 aA	84 abA	6.19 aA	5.42 aB
PEG+KNO_3	78 bB	85 aA	4.94 bA	5.18 aA

[1]Means followed by the same letter, lowercase in the columns and uppercase in the rows, do not differ by the Tukey test at 5% probability.

However, according to Luna and Moreno (2009), the sensitivity to these factors varies with the species. PEG may restrict oxygen diffusion in the solution, affecting seed respiration (MARCOS FILHO, 2005; NASCIMENTO; COSTA, 2009), and even inducing a secondary dormancy (TRIGO; NEDEL; TRIGO, 1999), affecting also the uniformity and percentage of germination.

No significant difference among the times of priming (Table 5) regarding the electric conductivity in both temperatures was observed. For 24 hours, no significant difference between the temperatures was observed. On the other hand, for 48 and 72 hours, the electric conductivity of the seeds primed at 15° C (50.28 and 49.66 µS cm^{-1} g^{-1}) were higher than those observed in seeds primed at 25 °C (43.07 e 37.18 µS cm^{-1} g^{-1}). These results may have occurred due to delays or failures that occur in the cell membrane reorganization when the seeds are primed under low temperatures (MARCOS Filho, 2005).

Table 5 – Means of electric conductivity (µS cm^{-1} g^{-1}) of seeds primed in two temperatures and three times.

Temperature (ºC)	Time (hours)		
	24	48	72
15	43.34 aA[1]	50.28 aA	49.66 aA
25	43.53 aA	43.07 bA	37.18 bA

[1]Means followed by the same letter, lowercase in the columns and uppercase in the rows, do not differ by the Tukey test at 5% probability.

When the electric conductivity of the control (105.08 µS cm^{-1} g^{-1}) are compared with each treatment from the factorial (Table 3), an expressive decrease in the values was observed, showing that there was a reorganization in the membrane systems of the primed seeds. These results corroborate with those obtained by Fanan and Novembre (2007) and Pandita, Anand and Nagarajan (2007), who verified the same behavior in seeds of eggplant and chili after the priming, in relation to the control.

No significant difference among the times of priming for electric conductivity was observed (Table 6), except when PEG+KNO_3 was used, showing higher means after 72 hours of treatment (55.27 µS cm^{-1} g^{-1}) and lower values after 24 hours (42.71 µS cm^{-1} g^{-1}). Electric conductivity observed in seeds primed for 48 hours (46.87 µS cm^{-1} g^{-1}), presented no difference for both times.

Among the solutions, in general, the highest electric conductivity was observed in seeds primed with KNO_3, and the lowest when water was used. These results are related with the uptake of K^+ and NO_3^- during the priming with KNO_3 and the subsequent release of these ions in the water used for the electric conductivity test (SANTOS et al., 2008).

Table 6 – Means of electric conductivity of seeds primed in four solutions and three times.

Priming solution	Time (hours)		
	24	48	72
Water	25.92 cA[1]	31.15 cA	24.76 bA
PEG	43.16 bA	40.90 bcA	37.24 bA
KNO_3	61.92 aA	67.78 aA	56.41 aA
PEG+KNO_3	42.71 bB	46.87 bAB	55.27 aA

[1]Means followed by the same letter, lowercase in the columns and uppercase in the rows, do not differ by the Tukey test at 5% probability.

CONCLUSIONS

Priming improves the vigour of eggplant seeds and does not affect the viability. Priming in water or KNO_3 is efficient to improve the vigour of eggplant seeds. Priming in water or KNO_3 can be used at 15 or 25° C for 24, 48 or 72 hours.

ACKNOWLEDGEMENTS

FAPEMIG, CAPES and CNPq for financial support.

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